Laminated, plate-shaped element with position fastening for an adhesively bonded assembly

The invention relates to a laminated, plate-shaped element with position fastening, comprising at least a first and a second substrate, which are joined together, at least indirectly, by adhesive bonding, and also with at least one support element associated with the first substrate in order to fasten the laminated element to an infrastructure and active position fastening of the second substrate, at least in the event of failure of the bonded joint.

Laminated, plate-shaped elements, which are composed of at least two substrates and of an adhesive layer joining the elements together by surface bonding or of a spacer frame adhesively bonded to the two substrates, may be fastened in a known manner without a frame to structures, by fastening, to the infrastructure, only the substrate facing the building. Examples of such elements and of their fastenings may be found in Documents EP 277 535 A2 and EP 595 062 A1. The Applicant sells and uses support elements of this type (undercut blind hole and anchoring of a support element in the form of a bolt with undercut dowel) with the name SGG Point XS.

For safety reasons, purely adhesive fastening of the substrate placed on the outside is, however, most of the time supplemented with mechanical means, which form at least one position fastening of the external substrate in the event of failure of the bonded joint. According to Document DE 693 10 389 T2 (corresponding to EP 552 101 B1), a substrate close to the building of a curtain wall element made of insulating glazing is fastened by means of discrete supports mounted on the latter, while the outer substrate, away from the

building, is held in place only by the spacer frame and the adhesive bonding. In order to ensure the positioning of the outer substrate, metal clips are provided here that are fastened to the discrete supports and catch, underneath, on the lower edges of the two substrates.

Document EP 319 695 A1 discloses position fastening for curtain wall elements made of insulating glazing, which are entirely bonded to the infrastructure in the form of what is called "structural glazing". In a variant, the position fastening is formed by pins, which catch in undercut blind holes in the outer substrate, away from the building, of the insulating glazing elements and are retained by the infrastructure in the event of failure of the bonded joint.

Document DE 197 51 124 C1 describes a laminated element with supports that pass through one of the substrates and are fastened by means of a undercut dowel in a undercut blind hole in the second substrate. A similar solution is disclosed in Document DE 100 54 816 A1, in which a pin-type support is fastened by means of a curable filling compound in a blind hole in the second substrate.

It is an object of the invention to provide a laminated, plate-shaped element for the building industry, with simple position fastening.

This problem is solved according to the invention by the features of claim 1 and of the independent claim 17. The features of the dependent claims provide advantageous embodiments of this invention.

The secure mechanical fastening of the first substrate suffices in principle as the basis for indirect relative position fastening of the second substrate. Preferably, the relative position fastening of the two

substrates is provided by fitting at least one fastening element that passes through the joint plane between the two substrates and engages in the two substrates. The fastening acts in a particularly discrete manner and independently of the supports for the laminated element.

It goes without saying that the number of fastening elements to be installed per laminated element depends on the area of the laminated elements, possibly on the mounting position (vertical, inclined or horizontal) and also on the weight of the substrate to be fastened.

In principle, insulating glazing elements could admittedly also be provided with such position fastening elements. A preferred use of these position fastening elements applies, however, to laminated substrates, comprising two substrates and an adhesive layer joining the latter together by surface bonding. The rest of the description therefore relates to this type, without in any way wishing to exclude other forms thereof.

The laminated elements may be equipped with other functional elements, particularly electrical elements, for example solar cells housed between the substrates, heating layers, antenna elements or alarm elements. It goes without saying that the position fastening or alternatively the corresponding fastening elements must always be installed so as not in any way to impede the aforementioned functional elements.

Although this is not absolutely necessary, but nevertheless highly recommended, the actual support for the laminated elements on an infrastructure catches on only one of the substrates, in particular advantageously only that face of the substrate located on the opposite side from the functional elements. Consequently, there may be freedom of choice in where

to place them, taking into account the requirements imposed by the static and dynamic loads and also by the infrastructure. The laminated element face left free in the mounting position therefore remains intact.

Laminated or insulating glazing elements, which are in turn adhesively bonded to an infrastructure (structural glazing), may however also be provided with the position fastening according to the invention.

Similarly, staged elements, in which one (larger) substrate is held in place via its edge at discrete points by clips onto an infrastructure or in a frame, while a second (smaller) substrate is only bonded to the first substrate, may receive a position fastening element of the type described here. Another application possibility relates to elements attached at discrete points to the edge, in which elements the substrate to be fastened has, in the region of the supports, only recesses facing the fastened substrate of the same size.

Finally, it is also possible to provide such position fastening directly between a spacer means adhesively bonded to the two substrates, whatever the shape of a peripheral frame, or only in segments, and one or both substrates, that it joins together. This embodiment may be applied not only to the usual spacer means in the form of solid (metal, plastic, ceramic, glass) sections but also to the spacer means, likewise known per se, produced in situ, for example by extrusion or by injection molding. It is even conceivable for the position fastening to be placed again between the two substrates to be fastened, one relative to the other, by passing through the spacer means. Of course, in the case of an insulating glazing element with an intermediate space between the substrates that are sealed off in a gastight manner, measures must be taken

to ensure that the position fastening does not compromise the sealing of the arrangement.

It goes without saying that the use of the position fastening according to the invention does not exclude support elements on the infrastructure also supporting the second substrate in addition to the first substrate.

As materials for the laminated elements, it is possible to consider, beside transparent materials like glass, preferably toughened or partially toughened glass, and plastic, other materials such as metal sheets, stone or marble plates, etc. Of course, any pairs of different materials may also form a laminated element of the type discussed here.

It is not absolutely necessary for the fastening elements to be firmly joined to the two substrates (or possibly with the spacing means and the substrate or substrates), even though their simple separation from the laminate must be prevented. In the case of position fastening, a certain initial movement is quite admissible. The fastening elements have only to reliably prevent the propagation of this movement beyond the extent still acceptable. The bond joint will not yield suddenly, but via a creep process, thus retaining a certain residual adhesion. The minimum requirement imposed on the fastening elements is therefore not guaranteeing any more the adhesion of the two substrates perpendicular to their surface extension. However, they may also fulfill this condition with forming and/or appropriate fastening to or in the substrates.

According to a first embodiment, a fastening element is introduced into a drillhole passing through the two substrates, and preferably in such a way that it terminates flush with the outer faces of the two

substrates. Modern manufacturing conditions make it possible, even in substrates that are drilled before the manufacture of the laminated element (laminated substrate) and are then thermally toughened in order to increase their mechanical strength, to produce isolated drillholes with sufficient positional precision in such a way that they are aligned along any one axis with small deviations in the laminate of the two substrates. Consequently, it is possible to mount pin-shaped fastening elements of the type considered here a posteriori at little expense in the finished laminated element.

It goes without saying that the adhesive layer between the two substrates must also have a recess for passage of the fastening element. This recess should possibly have already been made before assembly, or subsequently, by appropriate means, when the fastening element has been positioned only after assembly of the substrates.

If for example a thermoplastic adhesive sheet is used, a fastening element may then be heated above the melting point of the adhesive sheet before it is installed and then pushed right in through the adhesive sheet. With this method, it would be unnecessary to make a separate hole in the adhesive sheet and a fastening element would be fastened axially and radially by means of the adhesive layer that adheres thereto.

If the two substrates are bonded together by casting a curable casting resin (as is widely used in the case of solar modules), a fastening element may already have been introduced before the casting and then fastened axially and radially with the casting resin, if sufficient adhesion is guaranteed between the fastening element and the casting resin.

The fastening elements may also be fastened in another manner to at least one of the two substrates, for example by interlocking and/or by separate bonding. If fastening elements made of plastic or soft metal (for example pure aluminum) are used, these may, by intrinsic elastic or plastic deformation, compensate both for any undersize of the drillhole in the substrates and slight lateral offset of the individual drillholes. Elastically or plastically deformable fastening elements are for example collet sleeves (longitudinally slit hollow pins) or pins provided with longitudinal or transverse external ribs. Thanks to their elastic and/or plastic deformation, the respective fastening elements are radially and axially fastened by them being clamped in the recesses provided for this purpose.

According to another embodiment, one of the substrates has a through-drillhole and the other substrate a blind hole in alignment with the latter. The fastening element is introduced before or after the two substrates are assembled, preferably again in such a way that it does not project onto the mouth of the through-drillhole. It may be mounted and/or fastened in the manner described above.

According to yet another embodiment, a fastening element may, according to the invention, be housed entirely in the laminated element, in the manner of a parallel key, which is well known in the construction of machines. The outer faces of the laminated element may in this case remain intact; likewise, it is possible to dispense with special fastening of the fastening element. However, it is necessary to make, in the two inner faces of the two substrates in the laminate, recesses (grooves, blind holes, etc.) with positional precision as high as possible, and the fastening element must have already been introduced before the plates are assembled by bonding. This

provides one solution of the problem, which admittedly is particularly attractive looking from the outside, because it is barely perceptible, however its implementation is relatively expensive.

This could be implemented in such a way that, after the recesses have been made in the two substrates to be assembled, the first substrate is initially placed with the recess facing upward, the fastening element is introduced into the recess, then an adhesive film is possibly laid on top, and finally the second substrate is placed in such a way that the fastening element is introduced into the recess in the second substrate. Next, the bonded laminate may be manufactured. During adhesive bonding with a casting resin, a spacer frame is introduced in a known manner between the two substrates, and the intermediate space thus formed is filled with the casting resin.

The fastening elements may themselves be made of any (sufficiently strong) material and have any shape whatsoever, for example with a cylindrical, elliptical or polygonal cross section, they may be hollow or solid, smooth or ribbed, with steps, etc. Of course, the dimensions of the recesses in the substrates and of the fastening elements must be matched to one another in such a way that, should the substrate to be fastened creep, any extraction of the fastening element under a shear load is practically excluded. Moreover, no substantial load is exerted on the individual fastening element, so that it does not have to be exaggeratedly strong.

Other details and advantages of the subject of the invention will become apparent from the drawings of an illustrative example and from its detailed description that follows.

In these drawings, which are simplified representations with no particular scale:

- figure 1 is a sectional view of a first embodiment of a laminated element according to the invention, in the region of a support and of a position fastening element; and
- figure 2 shows a second embodiment, similar to figure 1, with an alternative form of the position fastening element.

In figure 1, a laminated element 1 is composed of a first substrate 1.1 and a second substrate 1.2, here both made of glass. An adhesive layer 2 joins the two substrates together over their entire area. The substrate 1.2, placed below in the drawing bears, on its face turned toward the adhesive layer 2, a functional element 3 schematically indicated solely in the form of a coating. In a preferred embodiment of the present invention, the functional element is composed of a number of photovoltaic solar cells, and the laminated element 1 forms or comprises a solar module.

That face of the substrate 1.2 which is located to the outside/underneath and on the opposite side from the functional element 3 is provided with an undercut blind hole 4. Anchored into the latter, in a known manner using an undercut dowel, is a bolt-shaped support element 5, for example of the SGG Point XS type, with which the laminated element 1 may be fastened to an infrastructure 6 shown solely by a broken double line. The infrastructure may be a building wall, a support framework, a bridge or deck element, and the like.

The support element 5 does not penetrate as far as the plane of the adhesive layer 2 and of the functional element 3. It can therefore be positioned freely in the region of the surface of the laminated element 1, which surface is covered by the functional element 3. It goes without saying that several support elements 5 of this

type will be provided, depending on the size and the weight of the laminated element 1, which support elements together form the mechanical support for the laminated element 1 on the infrastructure 6.

It is repeated that this discrete fastening indicated by way of example does not exclude the combination of position fastening with other possible ways of fastening laminated elements of this type and with laminated elements that include a spacing means.

In the "solar module" application case, the laminated element 1 is as a rule mounted in an inclined position, obliquely with respect to the solar radiation, as is indicated here, for example on a building roof and/or on a support framework. Consequently, the adhesive layer 2 and the upper substrate 1.1 in the mounted state are permanently subjected to a downward sliding force. Of course, this force is taken up by the support elements 5. However, solar modules may by their nature be very hot in service, so that creep of the adhesive layer 2 cannot be completely excluded.

Close to the right-hand outer edge, to the outside of the surface region covered by the functional element 3, the substrate 1.2 is provided with a through-drillhole 7. Substantially in axial alignment with the latter is a through-drillhole 8 made in the substrate 1.1. The drillhole 8 has a larger diameter than the drillhole 7. A fastening element 9 with a thicker head part 9K and a shank part 9S is introduced into the two drillholes 7 and 8 in such a way that the step at the transition from the head part 9K to the shank part 9S bears on the adhesive layer 2 (or is also embedded in the latter). The shank part 9S passes through the plane of the adhesive layer 2 and engages in the drillhole 7 in the substrate 1.2. The head part 9K is located in the larger diameter drillhole 8 in the substrate 1.1.

The length of the fastening element 9 corresponds approximately to the total thickness of the laminated element 1. Consequently, it ends up at least approximately flush with both external faces of the substrates 1.1 and 1.2 and does not project beyond them. It is preferably fastened in the drillholes 7 and 8 by means of an adhesive, this fastening constituting only protection against dropping.

In the event of failure of the bonded joint, or alternatively should the adhesive layer 2 creep, the upper substrate 1.1 may in any case move relative to the substrate 1.2 until the wall of its drillhole 8 touches the fastening element 9. In this way, mechanical position fastening is established, by shape complementarity, of the bonded assembly held in place by clamping or, depending on the case, by the material, which also meets the requirements regarding the construction.

Figure 2 shows a variant of the position fastening. Here, only the substrate 1.2 has a through-drillhole 7, while a blind hole 8' is provided in the substrate 1.1. The blind hole is again placed at least approximately in axial alignment with the through drillhole 7. Here, the two drillholes have substantially the same diameter.

A cylindrical fastening element 9 is again introduced as position fastening into the two drillholes 7 and 8' in such a way that it passes through the plane of the adhesive layer 2. It is fastened in the drillholes by means of a heat-resistant adhesive. The outer surface of the upper substrate 1.1 remains intact, with no hole, in the region of the position fastening. The length of the fastening element 9 is matched to the depth of the drillholes 7 and 8' in such a way that the element can be mounted in the fully pushed-in position

without projecting beyond the lower face of the substrate 1.2.

For purely visual masking of the position fastening, the laminated element 1 may be provided, in the region of the edge on the surface of the substrate 1.1, with an opaque colored layer 10 which terminates in a pattern of spots toward the middle of the substrate. The colored layer 10 may for example be deposited by screen printing and baked while the substrate 1.1 is being toughened. Of course, in the "solar module" application case, it must be placed on the outside of the region of the surface covered by the solar cells.

In an alternative embodiment shown in figure 2, the blind hole 8' could be placed in the lower substrate 1.1 and the through-drillhole in the substrate 1.2. That end face of the fastening element 9 turned toward the outside would then advantageously be colored in the same tint as the colored layer 10.

According to another embodiment (not shown in figure 2), the fastening element would even be a little shorter than that shown here, and the drillhole in the substrate 1.1 would also be a blind hole. The fastening element 9 must then be placed in the aligned recesses/blind holes before the bonding is carried out.

It goes without saying that, just as was mentioned in the case of the support elements, several individual fastening elements illustrated in the figures as embodiment examples may be provided, when the size and the weight of the laminated elements so require. However, as a general rule two fastening elements will suffice.

One application of the position fastening to a laminated element provided with a spacing means may also be simply accomplished as in figures 1 and 2.

Instead of bonding over the entire surface with the adhesive layer 2, in this case a relatively narrow spacing means is formed, this being bonded to the latter only along the edge of the two substrates. The spacer means may either be fully penetrated by a fastening element, just like the adhesive layer 2, in such a way that there is relative position fastening between the two substrates 1.1 and 1.2. However, it is also possible to provide fastening elements only between the spacing means and one or both substrates. In each of these cases, the fastening elements pass through the bonded joint between the spacing means and the substrate in question, and they support the latter should there be any failure of the bonded joint.